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Lockwood, R. M.

Subjective tests for difficult
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Subjective Tests for Difficult Cases

A Practical Treatise For
Optometrists

2

Illustrated

By
R. M. LOCKWOOD

Author of PRINCIPLES OF OPTOMETRY, SOME EXPERIMENTS
IN OPTICS, THE TRIAL CASE AND HOW
TO USE IT, ETC.

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CHAPTER I.

REASONS FOR SPECIAL TESTS.

When the optometrist finds, with any particular individual, that the results obtained with his tests are contradictory or unsatisfactory, or that his prescription accepted at the time of the test has become no longer acceptable, it then becomes necessary that he try some other method. He might repeat his regular test in all its details, but this is not a good plan for more than one reason: It may lead to exactly the same result as before; the mistakes made, if any, being repeated; or it may cause a feeling of lack of confidence on the part of the patient, usually unjustified, that the optometrist has been careless, or possibly is not so skilled in his profession as he should be, and has previously made an error.

AMBLYOPIC EYES.—An eye is amblyopic when it is physiologically deficient in the sense of vision because of an imperfectly developed retina, or abnormal nerves, or defective visual brain centers. Under the same general head we might include those cases where there is obscurity of vision due to opacities, such as cataract, abnormally small pupils and roughened exterior surface of cornea, the result of trachoma or other ocular disease or injury. Where any of the above conditions exist, the retinal images will be very poor, so that the test types will have to be used much nearer than ordinary, or else some method employed in which the test object is a bright light. To such patients,

sometimes, a difference of two diopters in the correcting lenses will with the ordinary tests make no appreciable change in the ability to see, and occasionally the ocular condition will be so bad that acuity will seem to be about the same over a range of six diopters or more, the vision in each case being extremely poor. As to the detection of the possible causes of such imperfect vision, recourse may have to be had to the ophthalmoscope, though even with this they are often undiscoverable. Where there are any opacities of consequence in the eyes, the regular test with the concave mirror will make the fact known, and where there is corneal roughness the Placido disc or the ophthalmometer may be used, and the difficulty readily detected. Abnormal conditions of the iris and of the pupil will often be evident on simple inspection.

SENSITIVE RETINA AND RETINAL FATIGUE.—A sensitive retina is one in which there is intolerance of light or lack of persistence in the act of vision. Eyes troubled in this way are annoyed by the steady gazing upon the chart necessary in making the ordinary tests, an annoyance which disturbs the nervous balance of the patient to such an extent that he pays little attention to what the optometrist is saying, and makes perfunctory answers to his questions, which may be truthful or unconsciously untruthful and contradictory. Retinal fatigue, or tire, exists at times in all eyes, but abnormally in some, and these must be constantly on the move or else they do not see well. The retinal cells in these cases seem to become rapidly exhausted so that the test type which seems clear at first becomes more and more dull and misty the longer it is looked at. For both of these troubles the test should be a lively one with little call for steadiness of gazing; such as the test at one meter with special letter cards, to be described later.

IRREGULAR SPASM OF CILIARY MUSCLE.—The results in this case will be of the same general character as in abnormal retinal sensitiveness and fatigue. The visual acuity will vary from time to time but more slowly and at longer intervals, so that the routine of the test may go smoothly for a while, and then the amount of the ametropia make a decided change so that a different result is obtained from that to which the first portion of the tests would seem to point. The fogging method should be used when the symptoms seem to indicate that this defect is present.

LESIONS OF THE OPTIC NERVE OR OF THE VISUAL BRAIN CENTERS.—Vision is a function of certain portions of the brain, and the fibers of the optic nerve are the ways over which are carried those impressions from the retina to the visual brain centers which are interpreted as sight. If the optic nerve is impaired in any way there will be a corresponding defectiveness of vision, and if the lesion which produces this result is variable in its nature or intensity then vision itself will be variable. The same reasoning applies to the visual brain centers themselves. In these cases it is practically impossible to make out the true condition of affairs, and they can only be inferred. Fortunately they are of rare occurrence.

MUSCLE IMBALANCE.—In all the subjective tests the patient must look more or less steadily at the test charts, and where there is muscle imbalance the muscles may give way at times, thus producing poor vision by incipient diplopia, or, what will amount practically to the same thing, by the continual strain to avoid this. Irregularity of external muscle action is usually, except in the case of very stupid patients, easily detected

and measured. Any of the muscle tests will serve the purpose, but in some cases it may be necessary to partially relieve the strain during the examination with test types by the temporary employment of weak prisms, though to make the tests at a shorter distance than usual will in most cases be enough.

CONTRARY PATIENTS.—There are some people who seem to be built across the grain, and to take their greatest pleasure in saying "no" when "yes" is expected. They are so set in this habit that the optometrical test and its purpose are from time to time forgotten during the examination. The optometrist shows by his tone or action that he expects a certain answer to a given question as a matter of course, or the patient thinks he does, and promptly he states the contrary. The old habit is stronger than the desire to get good service, or where the optometrist charges a fee, to get the worth of one's money. With patients of this kind the optometrist should not give the patient the slightest chance to do anything except describe what he sees. If the patient is too familiar with the ordinary tests, however, something else should be substituted with which he is unfamiliar, or else he will take chances on what the questioner wants, and answer incorrectly accordingly. Again, there are others who enter the refracting room with their minds made up. For instance, they want a pair of glasses for near work, not for distance, and when the optometrist begins his usual test for distance, they at first protest, mostly from reasons of economy, and show antagonism, in some cases going so far as to decline to answer the questions, or at other times making non-committal answers which tell nothing or worse. For these there should be a special test whose relation to distant vision they cannot detect. Where such patients are found to need distance glasses as well as near, they

will always decline to accept the former, no matter how poor their sight may be, claiming that they can see as well as they ever could. Usually it is a waste of time to try to convince them to the contrary. Their minds were already doggedly made up before they entered the dark room.

RE-EXAMINATIONS.—These are what very often we do not like to make, but they are a necessary evil of the profession. Sometimes a prescription which is acceptable at the time of examination later ceases to be so. The trouble is often in maladjustment of the frame, or in the development of latent hypermetropia, overuse of the eyes with the new glasses; or, whatever the difficulty may be, it is usually not advisable to repeat the first test, but to change the method of the examination, not only because a special test, different from the first, may bring to light some mysterious, previously overlooked ocular trouble, but because a change of method of testing, where the previous one has apparently not been correct, is conducive to confidence on the part of the patient. The symptoms and the report of the patient on his return for re-examination will be the best guide as to what particular new method is to be followed. In some cases it will be found that the difficulty has been due to the optometrist himself, that he has made a mistake, in which case he is often more likely to discover it if the method of the test be changed. How many times have some of us gone over a column of figures, always getting the same answer, which we know to be wrong, until we almost feel that there must be something wrong with the science of mathematics; but change the order of the addition and the error suddenly comes clear, and we wonder how the error ever happened.

MALINGERERS.—By the term malingerer as applied to eye testing, we mean a person who deliberately tries to deceive the optometrist for some selfish purpose. The object to be attained may be simple vanity, as for instance when young men or women will wear glasses because it improves their appearance, and who are unwilling to acknowledge the truth, and therefore pretend to see better with lenses than without; or in time of war it may be due to the desire of the conscript to escape military service. This is not common in this country, however, as we have no conscriptive military service. Then, again, a workman may want to get damages after an accident, pretended or real, by claiming that his sight has been injured, or school children may wish to get out of school duties, or find an excuse for a trip to the city. All of these are possible reasons for malingering. The deceit may take several forms; total blindness in both eyes, total blindness in one eye, partial blindness in one eye, or partial blindness in both eyes. Of all these the last is the hardest to detect, for if the patient is intelligent and knows something of optics, which may occur, he can in all the tests make allowance for his claimed reduction of vision and make answers that will deceive the most clever. What the examiners seeks to do is to trick his patient in such a way that his claims are proved false. Usually it is a contest of wits in which the examiner sooner or later comes out winner. In making this test the patient should be steadily watched and if he attempts to feel his way by closing one or the other eye before answering the questions put to him, he should be cautioned that such action will invalidate his claim. The great point to be borne in mind is by the rapidity and variety of the tests to first confuse the patient, and then, if he is playing a trick, to catch him.

FITTING CHILDREN.—To properly fit children by the trial case is a test of the optometrist's art. Most children are timid. They have had in many cases some experience with the doctors, and have suffered more or less in consequence. When they are brought to have their eyes tested they think that here is the doctor again with another ordeal of some kind to pass through. The optometrist should do everything in his power to combat this idea and gain the child's confidence. Where the child is young there should be some one of the family present, or it will not be possible to do much of anything. The child should be allowed to examine the lenses to see what they are, to look into the mirror of the retinoscope to see that it is nothing but a looking glass; his attention should be diverted by inquiries as to school and school life; and thus incidentally, in some cases, considerable history of the case be attained from first hands. The child should receive a little preliminary lesson as to the nature of the test to be used before it is put into operation; for instance, if the age and the intelligence of the child warrants it, he should be given the test letter chart to examine in his hands without any lenses before his eyes; he should be questioned on these letters so that later when he looks at them from across the room he will know what to say. The regular adjustable trial frame should not as a rule be put on his face. This piece of apparatus is torture enough for some adults; for children it is still worse, and should not be used if it is possible to avoid it. The single trial frame will often be enough, and when this is not true the optometrist can make use of his fingers to hold the various lenses.

Many children are very susceptible to suggestion, and where they are asked a question which does not touch in any way upon their feelings or interests they are very apt to say unconsciously what the examiner seems to want. For this reason the questions

should be put with great care and without the slightest tone as to what the optometrist would like the answer to be. Also, often the child will speak in a low tone of voice, hard to hear, and this is to be expected. Where it is hard to keep his attention upon the charts, the method of testing at a distance of one meter should be used. At this distance the examiner can keep holding up fresh test cards, each of which will catch and hold the little patient's attention long enough, and more, for the optometrist to learn what he is seeking to know.

Children should always be tested for spasm of the accommodation and this can be done readily by the use of a plus 4. lens before the eye, to which they will not object, if they are first allowed to handle and examine the lens as above suggested. In fact, the tests should be so conducted that they will be diverted by the novelty of it all.

FOREIGNERS.—All foreigners are by nature suspicious if they do not understand the language of the country in which they are residing. Hence there should always be an interpreter present, or else the optometrist should know the language of his patient, when the tests can be carried on the ordinary way. Even with an interpreter present we must go a little slow, so as to be sure that there is no mistake.

ILLITERATES.—As a rule these will be found stupid in their answers, and the only reason that they will need glasses is for very poor vision for distance, or else presbyopic glasses for near work, not reading. Very often they will be carpenters, artisans, or workmen at other trades requiring them to work at a specified distance, in which cases they should be fitted for the special distance required, though the tests should be carefully

made to see whether there is any amblyopic condition present. Of course, some one of the illiterate tests should be used, and for that matter there are many cases where the use of these tests are advisable, even though the patients are not illiterate. In fitting illiterates no notice should be taken of the fact that they are illiterate, as they are apt to be sensitive on this point.

SOME SPECIAL CASES.—Occasionally imbeciles may be brought in for examination. These have probably come from the regular practitioner who has recommended that the eyes be examined and fitted. There is no use in testing these by subjective methods, and in fact the best way, where possible, is to courteously decline to take the case. Then again there is the lady who has very poor vision, but who declines to wear glasses, asking instead for "eye treatment." Usually she has decided ideas as to the relation between age and power of glasses to be worn; though this idea is not confined to the ladies, as sometimes men will make a request for the same kind of treatment. It is usually impossible to get these patients to consider the wearing of glasses. Finally there is the patient whose sight is failing, either because he has cataract or because of some pathological condition. He used to have a pair of glasses which he lost or broke, and since then he has never found a pair to equal them. He has been to many opticians and the result is always the same; his eyes are getting steadily worse, and it must be the glasses. He feels quite sure that if he could find a pair like those he used to have he would see well at once. These cases are better left alone.

CHAPTER II.

SPECIAL METHODS OF TESTING.

THE FOGGING METHOD.—This method is based on the idea that in cases of spasm of accommodation, something which must always be watched for, the spasm may readily be made to unlock if strong plus lenses are put before the eyes, and then the power gradually reduced. In cases of high hyperopia these lenses have to be extra strong, while in myopia they would be reduced to suit the case. As a rule, however, where there is spasm of accommodation a plus five lens will be the right power to start on, though some use higher powers. The desire of the eye is always to obtain clear vision, and when it has been fogged, as above described, this desire comes into conflict with the spasm and the latter gives way, after a few minutes' ineffectual struggle to continue.

Having made all the preliminary tests as a matter of record, place in front of the eye to be tested a plus 5 diopter lens, and direct the patient to look at the two distant charts, first one and then the other, the letter chart at 20 ft. and the clock dial. They should both be badly blurred, or else there is hyperopia of medium or high degree present in which case the lens power can be increased as stated above. Now slip in front of the plus 5 in the trial frame a minus .50; this reduces the combination to plus 4.50, and there should be an improvement present on the charts. If there is spasm of the accommodation present this improvement should be of an undue amount, and if astigmatism is present the lines in one

direction may begin to be seen better than in the others. Whether this is so or not, slip into the third cell of the trial frame a plus 4.50; this makes the blur very much worse again, but the eye is still fogged; next withdraw the minus .50, and then the plus 5. The result of this manœuvre is to cut the power of the lens before the eye from plus 5 to plus 4.50 without taking the eye out of the fog, this latter being the key note of the system. Repeat the process until one set of parallel lines on the clock dial chart is black and clear and the others not, when minus cylinders should be applied with axes at right angles to the best visible set of lines, until all the lines on the chart are equally clear. Where no astigmatism develops this would be omitted. Next, following the procedure as stated above for keeping the eye in the fog, add stronger and stronger minus spheres until the best acuity is reached. As all this is going on, continually check up the work by holding in front of the combination after each trial a plus .50 lens to see if it causes a slight blur. The lowest minus with which this blur is produced, combined with the plus fogging lens and cylinder already in the frame, if any, gives the correction sought. This method has the disadvantage of being slow, but may be employed where there is the slightest reason to suppose that spasm of the accommodation is present. A shorter method is described in Chapter 9.

STENOPEIC SLIT METHOD No. 1.—In this test we make use of the principal meridians of the eye to see what the difference is in their refraction, if any. The advantages claimed for the method, are that if there is astigmatism present it can be detected at once; also that the slit cuts down the amount of the light falling upon the pupil, and consequently the retina, to such an extent, that spasm of accommodation, if it exists, is removed.

The possible disadvantages are that because of the decrease in light falling on the pupil the same will be unduly dilated, thus bringing into play the periphery of the pupil which sometimes is of a different refractive power from the center, and hence a false result is reached. Moreover, the test must be made with care, since to get good results the patient's eye must be directly behind the slit, otherwise there is a sort of dazzle from the edge of the slit which interferes seriously with the test. The first step is to develop the meridians of greatest and least power with the clock dial, then place the slit in one of these meridians and direct the patient to look at a special chart made of series of parallel lines arranged as to their width and spacing in accordance with the rule for the Snellen chart, the widths of the lines



Fig. 1.—Stenopeic disc.

to be one degree of arc and the spaces to be the same. These can be copied from the letter charts without the necessity of any figuring. Take first the 30 ft. type as the model and make the lines the same width as the letters there shown, repeat with the 20 ft. letters in the same way; also with the 15 ft. and 10 ft. This special chart of parallel lines is to be so placed that the lines are

at right angles to the direction of the slit; for instance, if the two principal meridians have been found to be 90 and 180 degrees, and we commence the test with the slit vertical, then the parallel lines should be arranged horizontal. Use this test chart and proceed in the usual way until the lines are seen the clearest, with the contrast between black and white the sharpest, and also until the addition of plus .50, or in some cases a plus .25 diopter lens, will slightly blur the edges of the lines. The finding, whatever it proves to be, will be the correction for that meridian. Now swing the stenopeic slit to the opposite meridian, make the parallel lines at right angles to the new position and proceed as before. Make a note of the finding, join it to the finding of the other meridian; change the result to the corresponding spherocylinder, remembering that we are not dealing with axes but with meridians, and set the calculated spherocylinder up in the trial frame and direct the patient's attention to the clock dial chart in order to check up. It may be found necessary to increase or decrease the power of the cylinder used a little, and to get this it



Fig. 2.—A test chart to use with stenopeic disc.

may also be necessary to fog the patient a little, say with a plus .50 held in place with the fingers. In any event now turn his attention to the distant letter chart and increase or decrease the sphericals if better vision can be attained by so doing. It will not be out of place here, in connection with this method, which is extremely reliable though a little slow, to give here the rule for

changing the findings, which are exactly the same in nature as retinoscope findings, to their equivalent sphero-cylinders:

Take either one of the meridian findings as the sphere of the sphero-cylinders; for the cylinder of the sphero-cylinder deduct the value of the first meridian from the value of the other, the axis to be that of the meridian first taken. Do not confound this with the crossed cylinders. In this method, as in retinoscopy, we have to do with meridians, not axes. Suppose the finding is as follows: + 2 meridian 180° , — 3 meridian 90° , the corresponding sphero-cylinder will be as follows: + 2 \odot — 5 cyl. ax. 180° .

STENOPEIC SLIT METHOD NO. 2.—In this method the general procedure is as given above in method No. 1, with the exception that the slit is tried over every meridian in turn; that is: meridians 0, 30, 60, 90, 120, 150, and 180 degrees, the test chart in each case to be the set of parallel lines as described, always arranged at right angles to the direction of the slit. The test is useless unless this is done, for the results obtained by lines arranged parallel to the stenopeic slit are peculiar and unreliable. Also be sure, as in the previous method, that the slit is directly in front of the pupil of the tested eye. From the results obtained in the different meridians pick out the meridians of greatest and least power; set up the correction in the form of a sphero-cylinder, direct the patient's attention to the reading chart; swing the cylinder used a little from side to side to get the exact axis, and then proceed to check up first on the clock dial chart and then on the letter chart.

STENOPEIC METHOD NO. 3.—In this variety of the test, we do not make use of any astigmatic charts at all. We first

turn the patient's attention to the letters of the regular Snellen chart and apply spheres until we get the best vision possible. Next we put the stenopeic disc in the frame in front of the lens which has given best vision; that is to say, the highest plus sphere or the lowest minus sphere that will give the ability to read most clearly the smallest possible type on the chart; and turn the disc in the frame until we find the spot where the patient can read the best; next, we add cylinders, either plus or minus, whichever will produce the effect desired, at right angles to the direction of the slit until vision through the stenopeic slit is the same all around the circle. Now place in front of the combination a plus .50. This should fog the letters a little. If it does not, change the sphere in the frame so that it contains the plus .50 and try again until the addition of an extra .50 does fog a little, when the slit should be put in place once more and the test repeated. This is for the reason that all tests with cylinders are the most sensitive when the eye is just a little fogged. Under these circumstances the accommodation cannot come into play. Now repeat with a fogging lens of .25 diopters, until the very best result is reached. This is a very reliable method.

DOUBLE PRISM METHOD.—This is a test based on the growth of diffusion images on the retina with increasing ametropia. The first thing is to arrange the test card to fit the double prism to be used. For this purpose mount the double prism in the trial frame; put in such lenses as will make your own eye corrected for 20 ft., and then look at the largest letter O on the chart. Be sure that the division line between the two prisms is exactly over the center of the pupil. Under these circumstances the O will be seen double. Now move backward and

forward until you find the spot where the two letters almost touch, the space between to be just wide enough to be noticeable. This is the point at which the test must always be made with that double prism. If a larger circle is used the distance would be greater, and if a smaller one is used the distance would have to be decreased accordingly. In using this test proceed as follows: Seat the patient at the distance from the chart as found above; adjust the double prism so that the division between the two halves of it will cross the center of the pupil. The patient will now see the letter O doubled, with the space as described between the two images, to which his attention should be called. Apply spheres until the space between the two images is the clearest, and then swing the double prism in the trial frame all the way around

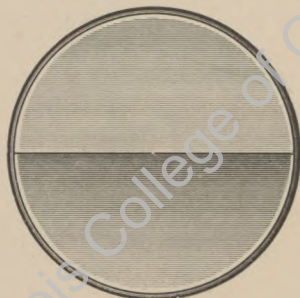


Fig. 3.—Double prism.

directing the patient to watch the two circles. If they remain the same distance apart all the way and as clearly defined as to their edges at every point, then there is no appreciable astigmatism present, and the strongest plus sphere or the weakest minus that will leave the adjoining edges the clearest will be the correction for the distance selected. On the contrary, if at the distance selected the two circles do not remain at the same distance apart

all around, and of the same clearness of adjoining edges, then there is astigmatism present. To find the meridians of greatest and least power, first fog the patient slightly until the outlines of both circles are dull all the way around; now turn the double prism in the trial frame and have the patient designate the spot where the two adjoining edges come closest together or overlap, as the case may be. Place minus cylinders with the axes at right angles to the direction of their combined diameter until the two circles are alike all around as to clearness of adjoining outlines, and the distance between these outlines as well. The correction in the frame to produce this result will be the correction for the distance at which the test is made. Now check up and alter the result, if necessary, in the ordinary way with both the letter test chart and the clock dial.

A modification of this test for amblyopic eyes is to use an illuminated transparent circle in front of a bright flat flame.

PERFORATED SCREEN TEST.—This is especially useful in cases of low visual acuity. Take a metal screen to fit in front of the flame of an argand burner or lamp flame. Have this bored with $1/16$ inch holes as many as will go in a space of one inch square, $1/8$ inch between centers. Put a piece of yellow

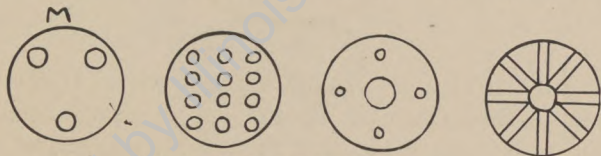


Fig. 4.—Some perforated screens.

glass in front of this to get rid of the dazzle and have the patient look directly at the points of light at the usual testing distance. Now fog the eyes sufficient to make the lights all blurred, thus

causing them to look like one light. Decrease with minus spheres until the lights begin to separate. If they all do so evenly, there is no astigmatism, but if there is astigmatism they will not come out evenly; the meridian of least curvature will come out first, with the result that each little light will be misshapen in the direction of the meridian of greatest power of the observing eye. These images will run together and will indicate the axis, which the patient can designate. Now add minus cylinders with the power of the same in the apparent directions of the lines of flame until each tiny light stands out clear as a circular point of light. The correction in the frame will be approximately correct, and can be checked up with the letter chart as usual. Where the amblyopia is considerable, the original finding with the perforated screen alone will usually be found to be the most satisfactory. Other designs of perforated discs may be used as shown in the figure

THE DOUBLE O TEST.—The chart for this test consists of double O's placed side by side and close together on a card which can be made to revolve so that the two O's may be horizontal, vertical or in any other meridian. The size of the O's should for ordinary cases be that of the 20 ft. letters on the Snellen



Fig. 5.—Double O chart.

chart, but for amblyopic eyes they would have to be larger or the working distance may be decreased. Let the patient watch the space where the two letters come closest together or overlap. Add plus spheres if necessary until the outlines of the letters are

blurred; then turn the chart until the point is found where the blurring at the junction of the circles is the least. Add minus spheres to make these edges clearer, and repeat the revolution of the chart. Finally a correction will be found, if there is astigmatism present, where in one position the adjoining outlines are clearly defined, while in other locations this is not true. Place the double O in the direction where this result is obtained, and add minus cylinders, axes at right angles to the diameters of the circles, to the trial frame combination until on swinging the double O completely around no difference in edges is noted. This will be the correction for the distance at which the test is made, but as usual it should be checked up by the test types for distance. Incidentally in this test it will be noticed that when there is astigmatism the distance between the two O's will not be the same at all points of their mutual revolution, while without astigmatism their relative positions will remain unchanged.

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CHAPTER III.

SPECIAL METHODS OF TESTING (*Continued*).

MONOCULAR PARALLAX TESTS.—A special trial case disc is needed for this. It should consist of a double disc, one fixed in its ring and containing, say, a $\frac{3}{8}$ inch hole. Over this there should be a smaller disc containing a stenopeic slit, quite narrow, and so made that by touching a little spring it will pass across the larger aperture of the disc to which it is attached. When set in position ready to be tripped, the slit should about bisect the pupil. It is evident, under these circumstances, that on tripping the spring the narrow beam of light passing through it will pass from the center to the extremity of the patient's pupil. Let the patient look across the room at a tiny point of light, preferably covered with yellow glass to get rid as far as possible of all stellate appearances. Now release the stenopeic slit disc as described, say in the vertical meridian. If the light seems to move then the eye is not focused for the light. If it moves in the same direction as the slit moves then the condition in that meridian of the eye is myopia, if it seems to move in the opposite direction then hyperopia is present. With no movement there is either emmetropia or hyperopia with accommodation. In this latter event the adding of extra plus power by means of lenses will soon produce the motion of myopia, which can then be decreased by reducing the plus lenses until we reach the point where we have the strongest plus lens which inhibits motion of the light. With myopia the contrary procedure would be followed, but to the

same ultimate point. After the vertical meridian has been tested and corrected, the other meridians may be tried in the same way, and the two principal meridians located. The correction for distance, whether spherical or astigmatic, can now be calculated and applied, when there should be no apparent motion of light in any meridian. When we consider that the most delicate physiological fact of the retinal and the visual machinery is the detection of motion, it is plain that we have here a good test for those amblyopic cases which are so troublesome in the ordinary routine with the trial case.

SCHEINER'S TEST.—This has come down to us from the middle ages. Take a pinhole disc with two pinholes instead of one, the two to be close together. Looking through this disc, placed directly in front of the pupil, we are not conscious of the two holes, though we are really looking through both. If the eye is emmetropic the images formed by these two holes will coincide on the retina, but if this is not so then they will not coincide. If one of the holes is so arranged that it is covered with red glass then it will be possible to tell by the relative position of the two images, one colored the other not, the dioptric condition of the eye. Let us suppose that the upper hole is covered with the red glass, then if the red image is uppermost on the retina we will have a hyperopic refraction, while if the reverse is true then the condition will be myopic. If only one image of the point of light is seen then there is emmetropia in the meridian on which the two holes lie or else hyperopia with the accommodation in force. To use this test have the patient look at a small point of light, say twenty feet away. Adjust the test disc carefully, and then swing it completely around in the frame. If the lights appear separate all the way, have the patient select

the point where they are the nearest together, and also state the location of the two images, on which side the colored image lies; compare this with the location on the disc of the hole covered with the red glass, and decide provisionally on the dioptric condition. If myopic in all directions, place minus spheres in the frame until the two lights coincide at some point in revolving the disc, and then apply minus cylinders, axis in the direction of the line joining the two test holes until on revolving the test disc but one light is seen all the way around; this, of course, with weakest minus cylinder possible. Where the conditions do not show myopia, add plus lenses until the two lights show in all directions; then decrease the dioptric power used until the two lights coincide in some one direction, and apply minus cylinder,



Fig. 6.—Scheiner's disc.

axis in this direction, until all doubling disappears for every direction, using the highest possible plus power that will produce this result. The result should be checked up on the distance chart.

THE CHROMATIC TEST.—This is based on the difference in the indices of refraction of the various colors which make up white light. This difference of refractive index produces what is called chromatic aberration, a natural phenomenon which causes a great deal of trouble in many optical instruments, but which is made use of here to determine the refractive con-



Fig. 7.—Chromatic disc.

dition of the eye. The disc used for the purpose is a special kind of glass known as cobalt-blue glass, so named from the fact that the glass from which it is made contains cobalt, and that it is blue in color. This blue, however, is a little deceptive, for not only does the glass permit blue light to pass, but also red. Almost all of the other colors are shut off. With this glass before the eye there will be formed on or near the retina two images of a bright point of light; one will be caused by the red rays of the light and the other by the blue rays. The focus formed by the blue (or rather blue-violet) rays will be slightly in front of the focus formed by the red rays, for the blue rays are the more refrangible of the two, and hence come to a focus sooner. The light intensity of these colored rays is low, so far as their effect on the retina is concerned, for if we represent the intensity of

yellow rays on the retina as one hundred the intensity of red and blue will each be considerably less than ten. It is assumed rather hastily from this that the accommodation will not be affected by these rays; that the eyes in looking through this variety of glass will relax, and that, therefore, by looking at the point of light and noting its appearance, we can tell at once the refractive condition of the eye. In an emmetropic eye, which is assumed to be one in which the retina, when all accommodation is relaxed, is in exactly the right position for the exact focusing of yellow rays, the blue image of the light would be in front and the red image behind. Each would be slightly diffused, therefore, and would coincide in size, so that the patient would see the light of one color only, a combination of red and blue. But now suppose the eye is hyperopic, just enough so that the focus of the blue rays would be exactly on the retina, then the red rays would be diffused and because of the increased size of the image would form a red ring around the blue point. In myopia the reverse would be the case, and there would be a red center with a blue ring or halo. In case of astigmatism, the image would be in the form of a cross, more or less well defined, one arm being red and the other blue. All these things are quite true, with one exception, and that is in regard to the relaxation of the accommodation, which in most cases will not hold good. The result is that while the test is extremely definite for myopes and hyperopes with insufficient accommodation, it is uncertain for all other cases where the accommodation can still be used. In these cases we will usually get the emmetropic sign, a colored disc without a ring, either blue or red, around it. There is one way, however, in which the test can be used; the patient can be made artificially myopic by fogging, and then the powers of the lenses decreased until the myopic effect disappears; then the

strongest plus or the weakest minus lens which will do this is the correction required. Astigmatism may be also corrected by first finding the meridians which show by the lengthening of the blue and red the image as a cross, more or less defined, and then applying the strongest plus or weakest minus necessary to dispose of one of the arms of the cross, to be followed by cylinders, either plus or minus, as the case may require, with axis at right angles to the meridian to be corrected, until the light becomes one small round dot. Furthermore, the cobalt-blue glass test may be used in some cases for testing the amplitude of the accommodation by finding the extremes of lenses, from lowest minus to highest minus, or from lowest plus to highest plus, or from highest minus to highest plus, as the case may be, with which the patient sees the single colored disc of light.

This test is especially useful in cases of high hyperopia simulating myopia, as the characteristic sign of hyperopia, a blue center with a red border, is very easily recognized by the patient. It should also be tried in all myopic or supposedly myopic cases.

THE TEST AT ONE METER.—There is no particular reason why we should hold to the traditional 20 ft. of distance in all cases. Sometimes a patient is amblyopic and cannot make out the 20 ft. type letters because the pupillary angle of aperture in his particular case is too small. The angle of aperture is the angle formed by two lines joining the extremities of the pupil of the eye with the distant point looked at. The nearer the object the wider the angle. At one meter it is about six times as many degrees as at six meters, or 20 ft. It is true that the pupil will become somewhat smaller for near objects than for far, but it does not decrease anywhere so much as to one-sixth its previous diameter. It is evident that the amount of light coming from

any point to form its image on the retina is many times as great as it would be were the distance much greater; hence the image tends to be brighter, though there is a corresponding increase in the size of the retinal image to offset this. As the result of this increase of size, in many amblyopic cases a test at one meter will be successful while the test at 20 ft. will not be so. Then again in the case of children with very low voices, it is sometimes better to work at a close distance, since to properly make a test with such patients the optometrist must do a great deal of pointing, and this he can do better at one meter than he can at six meters. One point, however, is absolutely necessary, and that is that proper allowance must be made at the end of the test to correct the finding for distance, 1 D. less if plus lenses, 1 D. more if minus have been used. The best method in those cases that require this special test is not to have a fixed test chart at a distance of one meter, but to prepare a series of small cards, which can be held in the hand as wanted. The letters on these cards should be based on the Snellen system of measurements, but for a selected set of distances from 6 ft. down to say 20 inches. These cards can be prepared by the refractionist himself from the advertisements in the literary magazines, among which are always to be found black letters very similar to the Snellen form. By comparing these with the smaller letters of the regular distance charts their size may be estimated; for instance, if they are half the size of the ten foot letters, then they are five foot letters and will be so marked. As to an astigmatic dial, this can be removed from some of the optical catalogues which show photographic reproductions of this device. The general method of procedure in the test is similar to the ordinary methods, only the tests are made by holding up a card and having the patient read the letters on it at a distance of one meter. The same card

should not be used twice in succession. This will prevent any mistakes due to the patient memorizing the letters. In cases of doubt this method may be employed to check up the regular test.

RESOLUTION TEST.—It has been suggested, and probably put into practice here and there, to prevent the trouble due to patients memorizing reading charts, or guessing at the letters, and to avoid the uncertainty caused by the ability of many to read some letters much more easily than others, that a new kind of chart be used, a sort of checkerboard arrangement made up of alternate black and white squares, sometimes two, sometimes three and sometimes four of the black squares, the patient to tell how many squares there are in each case, or small dots in a circle may be used. The theory of this is all right, but the trouble is that the patient will in a short time be able to do some guessing because of the size of the retinal image formed by the squares when they are blurred, so that this method does not seem to have been put to much practical use; however, it might be prepared and used in some special case, for instance, illiterates who can count.

READING CHARTS WITH SERIES OF DECREASING LETTERS.—This is an excellent device, and is used here and there by quite a number of optometrists. Instead of arranging the test cards with rows of letters all of the same size, each row starts with a large letter followed by another smaller one and so on down to the smallest. By having the patient read one of these lines straight across much time will often be saved, whether with lenses or without. There are some patients who do not like to be made to read all the way down the chart several times when

they have already done so successfully once, while there are others who insist on starting at the very top of the chart and spelling their way slowly to the bottom. The method of having and using charts with decreasing letters would in these cases

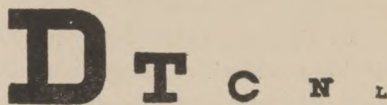


Fig. 8.—Decreasing letter chart.

give the optometrist the information that he is seeking without the danger of making him impatient because of the delay. This chart is especially good when so arranged that it can be raised and lowered behind a suitable perforated screen so that only one row



Fig. 9.—Clock dial chart.

of letters will be visible at one time. In this case there should be a counterweighted cord passing across the room convenient to the hand.

TESTING BY THE ASTIGMATIC DIAL ALONE.—

Where patients protest against the test with the distance chart for the reason that in their estimation they do not need distance glasses, or because they have been all through that before and are seeking something new, the complete test may be made on the clock dial alone. In this case the usual procedure would be followed, excepting that when the astigmatism has been found, if there be any, and properly corrected by a suitable cylinder, the attention of the patient can be drawn to the lines of the astigmatic dial instead of the letter chart, and the strongest plus or the weakest minus given that will make the lines stand out in the sharpest contrast with the white background. This result is so vivid in some cases that a troublesome patient shows great satisfaction because of the remarkable clearness of vision he possesses, whether absolute or comparative, as judged by the chart lines.

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CHAPTER IV.

SPECIAL METHODS FOR THE DETECTION OF ASTIGMATISM.

CROSS LINE CHART.—It will sometimes be found in a test for astigmatism, when the test has been brought down to the critical point, that the defective meridian will shift, and that no matter how much we may try we cannot get all the lines to look alike. Whether this is due to sudden or irregular accommodative action of the ciliary muscle, or whether there is irregular refraction in the eye due to an irregular corneal surface, a crystalline lens irregular in its layers, or slightly out of its plane,



Fig. 10.—Astigmatic cross chart.

is hard to say; but one thing is sure, the clock dial test is sometimes not a satisfactory one. In these cases we can use the cross line astigmatic test, which will always give satisfaction. In using this method, first get the meridian of greatest power in the usual way on the clock dial; then remove it and in its place use

a cross, the lines to have the same width as with the regular clock dial, but only a cross; this to be movable on its center and revolved until the arms of the cross correspond with the meridian of greatest power, already found, and its opposite meridian, 90 degrees distant. Use this cross to the end of the test. It is true that it only corrects the two principal meridians, but that is what we always seek to do in optometry; we can do nothing more.

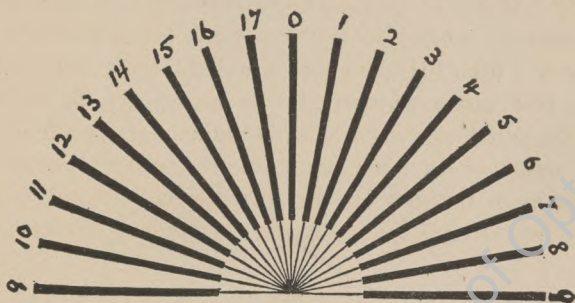


Fig. 11.—Astigmatic fan chart.

There will be no shifting of the meridian, for there are no lines there to shift to; furthermore, the eye does not have to do as much traveling around to watch lines in two directions as it has in six. Strange to say, when astigmatism is corrected in this way, and then the cross is removed and the dial used in its stead, simply as a check test, there is never any swinging of the lines; they all look alike. To get the best results the chart should consist of black and white lines mounted on a grey background.

NUMBERED FAN CHART.—This is a variety of chart which may be used instead of the clock dial chart. It is a fan shaped set of radiating lines, each line marked at its extremity with a large circle in which there is a number, usually that of the

corresponding degree upon the trial frame; or the circle may contain a letter. This device is a good one in the case of patients who fail to see the resemblance of the ordinary dial chart to a real clock dial, and to use the numbers of the hours accordingly. It is provoking to have a patient persist, in spite of all our explanations, in saying that the lines are clearest or blackest "in this direction," meantime sweeping his hands vaguely through the air.

PRAY'S LETTERS.—These are letters made up of short lines arranged, as to width and spaces between, to agree with the dimensions of the regular astigmatic charts. They do not



Fig. 12.—Pray's letters.

usually give as good a result in low grades of astigmatism as the clock dial or the fan, but are often useful for children. The assortment of them for this purpose should be much larger than

is usually the case and should be arranged so that they may be changed frequently, and the results obtained with one be compared with the results reached with others in which the direction of the constituent lines for the same letter are varied. Before using the letters the patient should be well drilled as to what you are trying to do with the test.

REVERSING MERIDIANS.—This is a variety of the usual method in which instead of gradually increasing the power of the cylinders we adopt the opposite method and apply a strong cylinder at once, for the purpose of temporarily reversing the direction of the meridian of greatest power. The patient should first be fogged so that the dial chart is badly blurred; then the chart should be taken in the hand with the lines from VI. to XII. held strictly vertical and brought gradually nearer and nearer to the eye under test till one of the meridians can be made out, while the others cannot, or the chart may be mounted on a stand. Now add a plus 2 D. cylinder with axis in the same direction as the lines first seen. On repeating the test if the astigmatism has been overcorrected the reverse axis will come clear first; if it does not then 2 D. cylinder is too low and a 4 D. may be tried. Just as soon as the astigmatism has been overcorrected, the cylinder can be reduced until the lines in all directions on the chart come out all alike. It will be seen that by this test the astigmatic condition can be very rapidly estimated, and that when there is high astigmatism present much time will be saved.

SWINGING CYLINDERS.—This is an old method, and a great favorite with some. Where the astigmatism is low in amount it is a very fine test, but where the amount present is

medium or high, it is often uncertain and unsatisfactory. The first step is to get the greatest possible visual acuity with the strongest plus lens or weakest minus lens which an additional .50 will not blur. Then take a plus .50 cylinder and place it in the frame over the spherical correction. Swing the cylinder all around the circle of degrees, the patient meantime closely watching the finest type that he can make out; let him state in what particular position vision is the best. If there is no difference then no astigmatism is assumed to be present, but if there is an improvement then the cylinder is prescribed with the axis at which it gives best vision. For fear there is accommodation in play the patient should be fogged 1 D. and the test repeated, when possibly the power of the cylinder may be increased. The trouble with this test is that the optometrist does not know how high he should go with the cylinders, hence he often stops with the use of a .50 either plus or minus, whichever will give the best results. In cases of high astigmatism, the patient will notice little difference no matter where the low power cylinder is placed, hence the assumption is easy that there is no cylinder needed. The best way to make use of this test is to keep it in reserve for those cases where there are troublesome symptoms with no apparent astigmatism. In these cases it is very often a very delicate test, due to the fact that in looking at small letters we are using the fovea centralis alone, while in the case of the clock dial we are using the whole macula lutea and much more.

CLOCK DIAL WITH REVERSED LINES.—This is a novel test which is apt, unless we are careful, to mix us up in reference to our astigmatic ideas and methods. In the ordinary form of clock dial the parallel lines correspond in direction with the meridians which they represent; for instance, the lines

from VI. to XII. are in the vertical meridian and are themselves also vertical. But now suppose we arrange them in the reverse directions; suppose we make each meridian on the chart of a large number of short parallel lines at right angles to its direction. Under these circumstances the appearance of the lines in the tests will at first seem contrary to the rules. When the eye is looking at the clock dial chart and the eye's vertical meridian is out of focus, then every particle of black on the chart will be lengthened vertically, so that the cross lines will be broadened and because of the diffusion, made dull; the particles of the vertical lines, however, will overlies vertically, and hence their black appearance be unchanged, while there being no lateral diffusion the spaces between the lines will be clear and distinct; and we will then say that the vertical lines are the blackest;



Fig. 13.—Cross lines astigmatic chart.

but with the reversed line chart this will not be the case. Here the vertical diffusion will cause the horizontal lines of which the vertical meridian on the clock dial is composed to broaden out, while the vertical lines on the horizontal meridian of the dial will be clear and distinct because of the lack of lateral diffusion. This will result in the meridian with the blackest lines being the correct meridian of the eye, while the meridian on the dial with the blurred lines will be the defective one.

It will be seen from the above that the astigmatic line charts are to be judged by the direction of their individual lines and not by the meridian they happen to occupy on the chart. This reversed line dial chart can be used with the ordinary dial as a continual check test; that is, the patient should always pronounce the blackest lines on the two charts as being at right angles to one another.

CHAPTER V.

TESTS FOR SMALL CHILDREN, ILLITERATES AND OTHERS.

THE "E" TEST.—In this a chart is used which is made up entirely of letter E's. Some of these look to the right, some to the left, some up and some down. They are printed to correspond with the rules on which the regular Snellen chart is based, and marked in feet or meters accordingly. Before they are used they should be put in the patient's hands and their principal peculiarity pointed out, that their arms point in various directions. With children the arms of the letter can be called fingers, and it will prove an easy matter to make them understand that when you point to one of these letters the patient is to point with his finger in the same direction that the letters point, up, down, to the right or to the left, as the case may be. It will be noted that this is a silent test. No one needs to say a word. As before stated the use of the regular trial frame should be avoided with children; the single light frame can usually be

made to do. First try the eyes together and separately, without glasses, to get an idea of the visual acuity; then put an opaque disc over the left eye and a plus 4 glass over the right. Let it remain in place a little while, and then take the E chart from the wall and bring it, say to a distance of two meters from the patient. Make the test for acuity here; next try the same thing



Fig. 14.—“E” test chart.

with a plus 2 D. lens in place; then try with other powers; follow this by the same test at a distance of $1\frac{1}{2}$ meters, then at 1 meter, etc. By comparing the different results the refraction can be estimated rather closely. The above method is mainly to avoid clanging lenses in the frame, very often a troublesome necessity with timid children. By the time the test, however, has proceeded thus far the child will have become used to it, and the presence of the examiner as well, and the estimated correction for distance can be set up and tried. The greatest point of all with

children is to look out for spasm of the accommodation, but the use of the plus 4 lens as described will relax this.

THE A. B. C. TEST.—This is especially for illiterates. These always take a great deal of interest in reading, though they cannot exercise the art themselves. The object of the method is to arouse their interest so that they will pay sharp attention, for lack of attention during the test is a marked characteristic of many illiterates. To this end they are to be taught the letters A., B. and C. Then they are to have their eyes tested on a chart which is made up of these letters only, each line of letters, of course, to correspond with the angular measurements of Snellen. This method will often give better satisfaction with bashful adults than will the E test with its continual pointing up, down, and sideways. This is also true with foreigners, though the writer would say here that the best way with them is to be able to speak their language.

THE NUMBER TEST.—This is another test especially for children and illiterates. The charts used are made of the ordinary Arabic figures. Many children and adults, who do not read,

2 4 1 6 5 8 9 0 7 3

Fig. 15.—Test Chart of numbers.

can count and understand figures. We judge of our success in using this chart by the improvement in being able to make out the figures. In this test, however, we must first make sure that the patient knows his numbers by trying him with large figures at a short distance without his glasses.

PICTURE TEST.—In this test we employ a picture of Santa Claus loaded down with all sorts of toys, or a chart showing all

the commoner objects of every-day life, all figured as closely as possible in accordance with the ordinary angle of the Snellen's chart. In England they use Punch for this purpose. The general method of making the test is the same as for all other tests

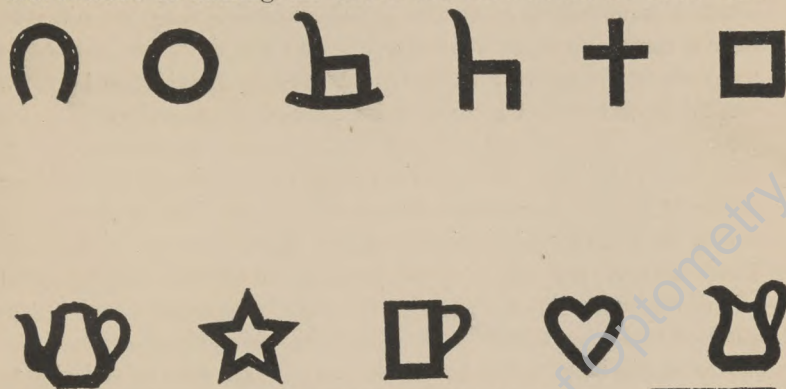


Fig. 16.—Children's test chart.

of this character, the finding of the strongest plus lens or the weakest minus lens that will make the smallest possible objects to be clearly seen.

ASTIGMATIC TESTS FOR CHILDREN AND ILLITERATES.—This is a difficulty, for the reason that for the detection of astigmatism, even with the most simply arranged apparatus, it is always comparatively hard for the patient to understand what is wanted; and this is doubly true with children. To attain success we must use apparatus in the way of a chart that cannot possibly be misunderstood and we must also drill the little patient in understanding the test. It is true we may give it up as too doubtful and fall back on retinoscopy, but this is a method whose findings must be checked up with the trial case,

hence, if possible, it would be better, in case of necessity, to be able to go to the trial case direct. The test must be more than all this; it must be interesting, since interest, not mere curiosity, is the basis of all childish intelligent action. The clock dial chart does not serve the purpose; there is too much to see, and where the child does not know how to tell time, or perhaps is not sure in doing so, all the benefit of the resemblance between the clock dial and the chart is lost.

ASTIGMATIC TEST WITH PRAY'S LETTERS.—

Where the child knows his letters this test can be used, but the charts used must be far more complete than those now to be had. There should be many letters appearing on different charts made of lines running in different directions from those forming the same letters on other charts. The child should examine these charts in his hands; he should also be given some special charts made in the same general way but with the lines shaded off to represent blurring, so that he may be taught by these, in comparison with the regular charts, to know what you mean when you ask "which letter is the blackest" or "which one do you see the clearest and best." He should also be taught to understand by these various lesson charts what you mean when you use the word "blurred." When all this has been taught it will be found quite an easy matter to proceed with the test in the usual way, since when a certain result has been reached with one card another can be presented in which the same parallel lines are used in forming the letters, but not in the same order and with the letters different. If a child should pick out a certain letter as blackest on one card and then pick out a letter on each of two other charts in which the same formation lines are used, then there would certainly be no doubt in the case. It must also be

added here that in giving the explanatory lesson to children under examination, as suggested above, they should also be taught to thoroughly understand what you mean when you say "are the letters all alike?" In order to avoid as much as possible the changing of lenses in the frame, which as stated above is not desirable for timid children, the method of blurring and then taking the chart and bringing it nearer and nearer until some of the letters can be made out, will usually prove to be the most satisfactory.

THE BROKEN "O" ASTIGMATIC TEST.—This chart consists entirely of O's with a piece out, a sort of narrow-mouthed C. The openings in the O's are made in different directions, the idea being that the astigmatism will be made known by the O which has the cut with the most sharply defined edges. The very first step is to teach the child the meaning of these letters in a way that he can understand. To this end there should be a set of supplementary charts made in which the cuts in the O are shown "blurred," and at the same time the terms blurred and black should be made clear. The O can be called a yard and the opening a gate, the child to be taught to point to the direction of the gate when the examiner points to the O. In so doing he should also be taught to exaggerate, pointing high up when the O has the cut above, and low down when the cut is below, etc.; in fact, it should be a sort of game. Furthermore, if he cannot be made to comprehend the term "blurred" the "gates" may be called "good" and "bad," the former when the edges are clear, the latter when they are not. The first step is to try the eye without lenses for visual acuity at 20 ft. or whatever the distance chosen may be. In doing this two things are to be watched very closely: how far the child can

properly distinguish the openings, and which ones are promptly and correctly seen among the smallest sizes recognized; this latter to give some idea of the astigmatism present, if such condition exist. Next put a plus 2 D. lens before the eye under test, and repeat the test in the same way; this to be followed by a plus 4, if the test demands it; or it may be necessary to go the other way and use minus lenses. One of these will be found the best, with due regard for the rule of the highest plus or the weakest

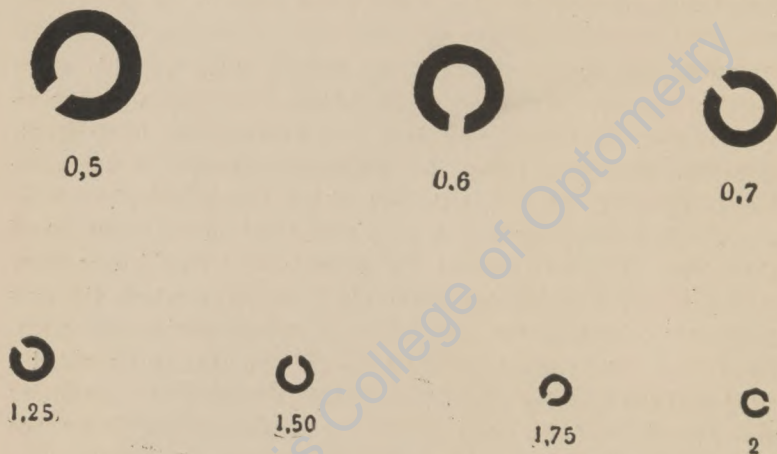


Fig 17.—Broken O test chart.

minus, and this of course will be the nearest to the true refractive condition. This we will call the test by steps of two D.; now repeat on the basis of steps of one diopter, cutting down the examination to such limits as the result of the first step justifies. Meantime, when the child has read down to a line where he begins to hesitate or make mistakes, then have him tell you when you are pointing on that line to the "good" gates and

when to the "bad." This will, as the result of several trials, give the axis of astigmatism, provided the eyes as shown by a comparison of the results already made, are slightly fogged. The next thing to make clear is in regard to the amount of the cylinder needed. For this it is better to work at a distance of one meter with a chart of O's especially prepared for that distance; that is to say, with O's figured on the basis of the letters of the Snellen chart from, say 3 meters down to $\frac{1}{2}$ a meter. This will permit you to point to the O's on the chart while at the same time you hold cylinders before the spherical correction before the eye, until the "gates" in any given line are all good. By carefully comparing the results of the above tests, the condition of the eye may be closely estimated. In making the prescription, however, allowance should be made for possible mistake, by undercorrecting not only the spheres but the cylinders as well.

Although the method of testing with the broken O's has been given here, it is very seldom that there will be any call to work with children so small that it must be used, since young children rarely are brought to the optometrist for glasses for better vision, but rather when squint is present. This is easy to detect and measure closely enough by the cover test, though it is a good and safe rule to be slow about infringing on the oculist's preserves by prescribing glasses for this condition in the very young.

CHAPTER VI.

MUSCLE TESTS.

The purpose of a muscle test is to deceive the eye so that the stimulus to binocular vision may be for the time destroyed in order to discover whether any of the external muscles of the eye are either strained or actually out of true. The deceit practiced usually takes the form of seeing with one eye the object looked at changed in form, place or coloring, while the other eye sees it correctly, with the result that we seem to see two objects when there is really but one.

When the eye is looking directly at some object, and at the same time there is another object to the right of the first, then the image of this second object formed on the retina will be to the left of the retinal image of the first object, for the eye, like all cameras, has reversed images. It is true that we see things right side up, but that is because the eye knows how to properly interpret the retinal image. The object and the image, then, being on reverse side, it follows that if we deceive the eye and cause the image of an object to fall on one side of the yellow spot of the retina, we will project the impression outward and seem to see the object itself on the opposite side. Suppose the right eye is looking directly at some bright object, but that the left eye is unduly turned in, then the image of the object will fall on the nasal side of the yellow spot of the left eye; but under ordinary conditions when an image is formed on the nasal side of the yellow spot it comes from an object on the temporal side of the

object, and we so interpret what we see. Hence the following will always be true; images seen by the eye through delusions will always seem to be on the opposite side of the visual line of the eye, before the eye, from what their images really are on the retina. If the eyes cross, that is, turn in, the image of the light seen by the turning eye will be to its own temporal side, and the lights will not seem reversed, though the eyes are so. On the contrary, when there is divergence of the eyes the two images seen will seem crossed.

THE SINGLE PRISM TEST.—Place a prism of eight degrees base up over the right eye. In conformity with the rules of prisms, the right eye in order to see the light single must look

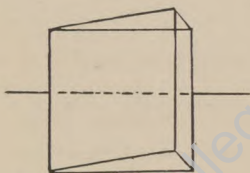


Fig. 18.—Single prism.

down, or towards the sharp edge of the prism, 8 degrees; but this it cannot do, for 4 degrees is the extreme limit for normal eyes, hence we must see the light double, the image in one eye falling below the yellow spot and the image in the other above the yellow spot. There must be no mistake in the arrangement of the prism; it must be exactly vertical, or else there will be an error. If under these circumstances the two lights apparently seen are directly over one another then there is no esophoria or exophoria, for the separation of the two lights has broken the fusion force of binocular vision, and the lateral muscles, if strain exists, will

tend to take a position of rest. These statements will not be true if actual strabismus exists, because the squinting eyes may not be functioning at all; but in this case there are other tests to be used which will clear up the point. To make the test more accurate, the object looked at can be a vertical line of light with



Fig. 19.—Line and dot chart.

a central aperture midway of its length of a circular form and of somewhat larger size. The lines will serve as guides to show when the prism is vertical. To measure the amount of the muscular imbalance, prisms may be placed over each eye, base in or base out, after the first prism, base up, is in place, as the case may require, until the two dots are exactly over one another. If such a prism be 3 degrees, base out, then there is esophoria of



Fig. 20.—Appearance of lines and dots in lateral imbalance.

3 degrees, for base out relieves and takes up the deviation of esophoria, while prisms, base in, take up the deviations of exophoria.

To test for hyperphoria, turn the first or disassociating prism base in; this tends to cause the eyes to diverge, but 8 degrees is more than most eyes can overcome, so the light is seen double, but horizontal. If the 8 degree prism is too weak a stronger one may be substituted. The line and dot, as explained above, can be used here also by turning the prism until the lines appear horizontal. Should they not form one and the same line, whatever prism, base up or down, as the case may be, that will

bring them so, is the prismatic correction required to measure the hyperphoria. If the prism that does this is base down over the right eye then there is right hyperphoria; if base down over the left eye, or, what is the same thing, base up over the right eye, then there is left hyperphoria.

This same test, which was first used by Graefe, can also be



Fig. 21.—Appearance of lines and dots in vertical imbalance.

used in a similar way for testing the muscles for reading distance though usually here it consists of a black line and dot drawn on a white card.

THE MADDOX NEAR TEST.—Another somewhat similar test is the Maddox near test. In this there is a horizontal line several inches long, from the center of which there extends upward

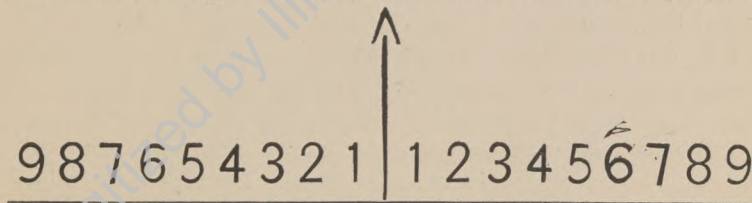


Fig. 22.—Maddox near test chart.

for a short distance the head of an arrow. To the right and left of the arrow head is a tangent scale, on the right side in black letters, on the left side in red letter numbers. To use this test, put a 10 degree prism over the right eye, base up. This will cause two numbered lines with arrows to be seen. Wherever the lower arrow points will be the measure of the lateral divergence or convergence, as the case may be, of the eye for near distance, esophoria if on the black side and exophoria if on the red side, the number on the scale to which the arrow points showing the extent of the deviation.

The single prism methods are based on the idea that by the displacement of one of the images on the retina the desire for binocular vision is destroyed, though this is not the only device which works on this same general principle.

THE DOUBLE PRISM TEST.—In this case the source of light is again a small point or circle. But the doubling of the image is done in one eye; that is, the light as seen by one of the eyes consists of two lights a little way apart. This effect is produced by placing before the eye a piece of glass ground in the shape of a double wedge, or two prisms placed base to base, each of about 4 degrees. This double prism must be centered carefully, so that the dividing line between the two prisms shall lie exactly across the middle of the pupil, thus causing the upper half of the pupil to form one image on the retina and the lower half to form the other, though the disc may be turned in any direction as the needs of the test may require. When this test is made the other eye should be covered and the patient's attention called to the fact that the light has been doubled; then this eye should be covered and the other exposed, a red glass meantime having been placed in the frame. Now the patient must notice

that there is one light, and that it is colored red; then both eyes may be uncovered, and the patient looks at the three lights. Sometimes he does not see them at once, then by repeating the covering and uncovering they can finally be made to all come into view and stay there. It will sometimes happen, however, that there is hyperphoria present, made manifest by the fact that binocular vision has been broken, and this may cause the eye behind the double prism to either rise or drop so that the center of the double prism is no longer in place, in which case the

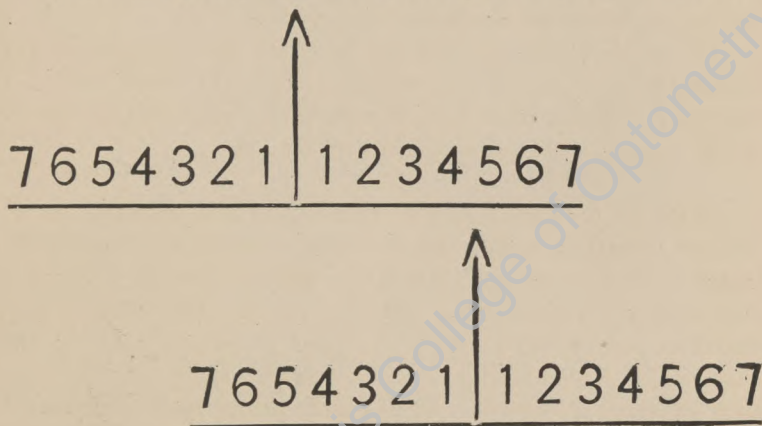


Fig. 23.—Appearance of Maddox near test chart in lateral imbalance.

patient will persist in seeing but two lights instead of three, one for each eye. By resetting the double prism this may be corrected. Now turn the double prism disc, if necessary, until the division line is exactly horizontal. If there is lateral imbalance present the middle light will be outside of the vertical line, and the prism, base in or out, that will bring it into line is the measure of the imbalance. To find the amount of hyperphoria

present, turn the double prism disc so that the two white lights are in a horizontal line. If the red light now is above or below this line then hyperphoria is present, and the prism, base up or down, which will bring it into line is the measure of the imbalance. Objection has been made to this test on the ground

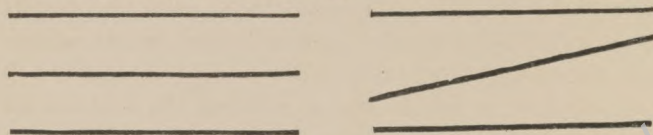


Fig. 24.—Triple lines as seen in test for cyclophoria. Right hand cut shows cyclophoria present.

that it makes an unnatural comparison, the retina of one eye compared with points outside of the retina in the other eye.

CYCLOPHORIA TEST.—This is a test with the double prism for near distance with a straight horizontal line for the fixation object. It has been brought forward by Dr. Savage. If with the double prism properly set the patient looks at the horizontal line the double prism will double it into two parallel lines. The other eye, however, will see it single, and lying between the other two. If this third and central line is not parallel to the others but slanting, then there is abnormal action of the oblique muscles, which is very apt to cause one of those baffling cases of cyclophoria that we sometimes meet. As to what shall be done in these cases the discussion is still open, as authorities differ.

MUSCLE TEST WITH STRONG CONVEX LENS.—This is based on a great change in the form of one of the images. A strong plus lens is stopped off so that only a very small space in its optical center is left uncovered. This is adjusted before

the eye, with the result that when a point of light is looked at, it appears as a blurred circular image on the retina. The image formed in the other eye, which has no lens before it, will be small; the retina will see the two different lights; the patient will fail to know that they are one and the same light, and will, therefore, make no attempt to fuse them, with the result that if there is any heterophoria present the small bright image will not be in the exact center of the blurred disc; the amount of the space to which it is out of the way being the measure of the muscle imbalance present. That prism with the base properly arranged, which will bring the small bright image of one eye to the exact center of the diffused image formed in the other eye, is the measure of the heterophoria. With this test a red glass may be put over one of the eyes, though this is not essential. This test is not much used because of the possibility of error due to the aperture of vision not always being exactly in the center of the lens.

THE TEST WITH THE COBALT BLUE GLASS.—This consists merely in placing the cobalt blue glass over one eye and having the patient look at the light with both eyes. The image formed by the cobalt blue glass is made up only of the red and blue light rays from the source of light. This makes the images on the two retinas different to a certain extent, but does not break up the fusion sense so completely as some of the other tests. By some it is said to be the most reliable of all muscle tests, provided the heterophoria is at least 2 degrees, though in some cases it will fail to act unless there be at least 4 degrees present. To get best results the light looked at should usually be a point, and the prisms required to make the two images one will be the measure of the muscle imbalance.

MADDOX ROD TEST.—This is generally accepted as the most satisfactory test of all. It is based on the distortion of the image of the light into a long drawn out line, so that there is absolutely no resemblance of any kind between the two images as formed on the two retinas by the same source of light. It consists of a cylinder of glass about $\frac{1}{8}$ inch in diameter, placed before the slit of a stenopeic disc. Sometimes it is made of a series of rods fastened side by side. This latter form is the best as it is most easily adjusted, without any regard for center-

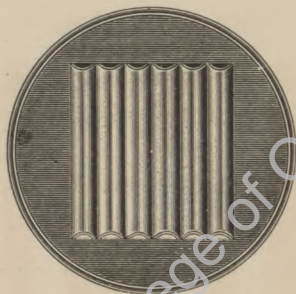


Fig. 25.—Maddox multiple rod.

ing before the eye. Sometimes the rod, or the multiple rod, is of white glass, sometimes of red. In the first case it is usual to put a red glass over the other eye, and in the latter a green one. After the disc is in place all lights should be shut off, except the one being used for the test, or else the patient will see as many lines of light through the rod as there are lights in his field of view, and this is confusing. Cover the patient's eye so that he is only looking through the rod. He will at once notice a long light streak, for this is the effect of the Maddox rod; now cover

the rod and call his attention to the colored light; now expose both eyes and tell him that he sees both streak and colored light. Sometimes he will say that he does not see both at the same time, in which case the test should be repeated until he does see both. Now turn the Maddox rod test in the trial frame cell until the streak is vertical; find out from the patient whether this streak runs directly through the colored flame or whether it is off to one side. In the latter case, there is exophoria or esophoria present, and the prism which will show the streak piercing the center of the light is the measure of the lateral imbalance. Now swing the rod in the frame until the streak is horizontal, which



Fig. 26.—Candle and streak in test with Maddox rod. The first cut shows no imbalance.

will be when the rod is vertical, and find out from the patient whether it is through the colored light, or below it, or above it. In either of the latter two cases that prism, either base up or base down which will put it into the intermediate position, is the measure of the hyperphoria.

In making the test with the Maddox rod it is not absolutely necessary that prisms should be used. The light can be made one inch in diameter; then the patient being placed nineteen feet from the light can be told that it is one inch wide, and asked how many inches, or widths of the light there are between the center of the flame and the streak. For each inch of space a $\frac{1}{2}$ -degree prism would have to be used to make the two dissimilar images correspond center on center. Suppose the patient says there is a space between light and streak of $2\frac{1}{2}$ inches; this would be 3 inches between centers, and a $1\frac{1}{2}$ -degree prism is indicated.

The claim is made for this test that the comparison between the two images is along the horizontal fusion line of which the macula forms a part, and that, therefore, it is more natural. In any event it is accepted usually as the most reliable subjective muscle test.

CHAPTER VII.

MUSCLE TESTS.—(*Continued.*)

BINOCULAR PARALLAX TEST.—This is a subjective test, one based on motion. No special apparatus is used for it. The light used as the fixation point should be at the usual distance of 20 feet. The optometrist should take his position in front but also to one side of the patient, so that as the latter looks past his head he may see the light with both eyes. Hold a card in front of one of the eyes; direct the patient to look steadily at the light and then remove the card quickly to the other eye. If the patient on being questioned says that he saw the light jump, then the direction in which it seemed to jump is a key to the heterophoria present, for this jumping motion will be contrary in direction to the deviation of the eye that is uncovered. The test should be repeated several times first with one eye and then with the other, as it will sometimes take several trials before the patient will be educated to the test, but when he is, the test will be found very exact. The prism which will destroy this apparent jumping will be the measure of the heterophoria.

THE OBJECTIVE COVER TEST FOR HETEROPHORIA.—Here the observer sees and judges for himself. He must take his position in front of and a little to one side of the patient so that the latter may look by him at the light with both eyes. Now hold a card in front of one of the patient's eyes, at

the same time looking intently at the eye behind the card from the side. Now suddenly shift the card to the other eye. If the pupil of the eye under inspection is seen to move then the direction in which the movement takes place is a key to the nature of the heterophoria. Now still intently watching the same eye, and having directed the patient to look steadily at the light suddenly bring the card back again. This time the eye, if there be heterophoria, will be seen to move in the opposite direction; that is, to a position of rest; and its direction of movement is a sign of the nature of the heterophoria present; for instance: suppose the eye when uncovered moves in, and when covered again moves out; then there is exophoria present and the prism which will destroy the motion, base in, is the measure of the imbalance. The result with one eye should be checked up by examining the other in the same way. Where the result is the same in testing both eyes, then it is simply heterophoria, but if the result is not the same with both eyes then there is paralytic squint present.

It is assumed in the above that there is no concomitant squint present. To clear up this point some of the following special tests for squint should be used.

INSPECTION TEST.—To estimate the amount of squint hold a candle in the hand at a convenient distance from the patient; let him watch the light closely; now let the observer bring his eye as close to the side of the candle as possible and scrutinize the corneal reflection of the candle in the patient's eyes. When the reflection is at the margin of a moderate sized pupil there is about 15 degrees of squint; when at the margin of the cornea, about 45 degrees; midway between edge of cornea and canthus, 60 degrees.

CORNEAL IMAGES.—Squint, or heterophoria, may be detected by the use of the corneal reflections. Let the patient look at the candle or other suitable source of light 20 feet away, the observer being seated facing him and to the right side, so that his head will not hide the light from either eye. Behind the patient, and to one side, place another light. With a small mirror held well to the left throw a reflection of this light upon the corneal surface of the patient's right eye and note the corneal image, paying no attention to the one made by the candle. Now

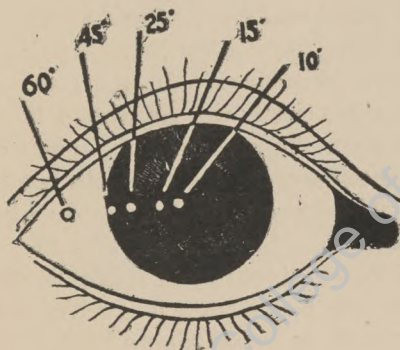


Fig. 27.—Deviation of eye in squint.

let the observer move his head sideways until he has cut off the view of the candle from the patient's right eye, meantime closely watching the position of the corneal image caused by the mirror, in relation to the center of the pupil. If the corneal image changes its relative position, then there is either heterophoria or squint present. By testing the left eye in the same way from the same side, and by testing each eye in the same way but from the left side, the muscular condition can be diagnosed.

OBJECTIVE COVER TEST FOR SQUINT.—This is a variety of the above whereby we may discover whether there is squint present, and if so, in which eye. Take a position as before; direct the patient to fix the light; put the card over the eye under examination, watching it as before from the side. Now withdraw the card but do not place it in front of the other eye. At the moment of taking away the card look at both eyes in rapid succession, or by looking midway between the two, the motion of both eyes can readily be made out at one and the same time after a little practice. Let us suppose that the right eye is being examined; if it should move when the screen is taken away, but the other eye not, provided this latter is fixing the light, then we have a case of heterophoria; for the eye was simply in a position of rest, and when it was uncovered it gave this up in order to fix the light, the other eye meantime remaining constantly fixed; if, however, the right eye does not move, then it probably squints; if, however, the left eye, as well as the right, should move when the card is removed, then that eye has squint, for when the right eye is uncovered and fixes the light, the left has given way as is clearly seen by its motion. The above test should be checked up by examining the left eye in the same way. If the squint is found in both eyes, then it is a case of alternating squint. The prism which will destroy the deviations found is the measure of the trouble present, whether heterophoria or heterotropia.

DUCTION TESTS.—Let the patient look at the candle or other light twenty feet away, and then apply prisms, base in, over either eye, starting with a low degree and working up gradually until the strongest is reached with which the patient can continue to see the light single. This will be the measure

of his abduction. For his adduction place the prism base out, and for superduction, or subduction, the prisms should be applied, base up or base down, over one eye, until single vision is no longer possible. The strength of prism which normal eyes can overcome is for abduction from 6 to 8 degrees, for superduction or subduction 2 to 3 degrees. In regard to adduction the amount will vary from 15 degrees to as high as 100 degrees depending upon how much the function is practiced and upon the individual; hence the amount of adduction possible has little diagnostic value.

In using the duction tests there are two points to be considered; the strengths of prisms that the eye can overcome and the relative powers of abduction and adduction. If the prism values which can be overcome are markedly less than the figures above stated the supposition is strong that the corresponding muscles are defective. If the relation of adduction to abduction varies much upon first test from the ratio of 3 to 1 or with practice a prism of 50 degrees cannot be overcome, the supposition is the same. In either case the test is not a definite one, but is merely indicative in its nature.

Sometimes rotary prisms are used in this test, in which case the results obtained will be higher.

FRONT TO REAR COVER TEST.—Hold a small bright object directly in front of the patient and about a meter away and have him look directly at it. In the case of children a small electric light will serve the purpose well, or even a small candle. Bring the object nearer and nearer rather rapidly, meantime watching the eyes closely; if either or both of them falter, jump, lag or make any peculiar movements, the suspicion will be paresis of the accommodation, or possibly of an individual muscle.

SIDE TO SIDE COVER TEST.—Hold a bright object in front of the patient and have him watch it. Insist that he is to hold his head rigid and that as you move the object from its position he is to follow it with his eyes only. Now raise the test object; lower it; move it to the left; move it to the right; also move it in various oblique directions, sometimes from the center of the line of vision in the various directions, sometimes clear across. Any faltering, jumping, peculiar movements of the pupils, or attempt to take awkward bodily positions is a sure sign of paresis, more or less marked according to the symptoms shown.

DIPLOPIA TEST FOR STRABISMUS.—The first step in these cases is to cultivate the diplopia, since most of those who have strabismus learn sooner or later to suppress the false image. Often the faculty of seeing this false image is very low. By persistence most patients can be led, however, to make out both images, the true and the false, though often it will be necessary to put a smoke glass disc over the good eye to permit of this result being reached. When the patient is at last able to make out both images, the next question to decide is whether the diplopia is due to paresis or simply to squint. To this end hold the candle flame directly in front of the patient, say at a distance of two meters, let the patient describe the two images he sees, and their relative location. Now move the light to various positions, and if there is any change in these relative positions, then paresis is present. This test may be modified by making the source of light used for the test a line, in which case, in the presence of paresis, the change in the position and direction of the two images will be still more marked.

These tests for paresis of the ocular muscles are not given

here with the idea that the optometrist will be able to do anything for them with glasses. but to make him able to diagnose the cases, so that he may recommend those who suffer from them to seek the proper medical or surgical aid.

CHAPTER VIII.

TESTS FOR MALINGERING.

TESTS FOR MALINGERING.—There is not any great probability that the optometrist will have any worse case of this than the young person who wants glasses for the style of it, but should the unexpected happen it is a good thing always to know what to do. Of the different varieties of malingering the most common is the claim that one eye is badly injured in its seeing power, though there are other varieties of claims of this kind that may be made.

PUPILLARY REACTION.—Throw a bright light suddenly into the eye. The pupils ought to respond to the light stimulus. If they do not, the case is probably not one of malingering.

MUSCLE TESTS.—All of the muscle tests may be tried. If the party under suspicion can be led to acknowledge vision of an image which must come from the eye claimed blind, this will be sufficient proof of trick; though this method will not serve where only partial loss of vision is claimed.

THE BAR TEST.—Have the patient read with both eyes open a printed page, in front of which a bar or pencil is held; shift the bar from place to place, watching both it and the patient closely meantime. If there is vision only in one eye, or even if in the supposed poor eye the visual power is claimed to be low, the bar will prevent the steady reading of each line of print, but where there is binocular vision the bar will be no impediment, the two eyes looking around it, and hence the supposed bad eye must really be good.

SURPRISE TESTS.—These will apply where total loss of vision in one or both eyes is claimed, usually the former. Cover the supposed blind eye; then suddenly remove the cover and present at the same time to the patient something grotesque, like the gelatine colored faces sold on the streets, and which can be contorted into such extraordinary facial forms. A laugh will settle the question at once; or weapons may suddenly be presented.

FRIEND TEST.—This needs a special chart, or transparency, on which is written in alternate letters of red and green the word FRIEND. Now place over one eye a green glass and over the other a red one. If the supposed malingerer reads the whole word then binocular vision is present.

WALK A LINE TEST.—First have the patient walk briskly along a chalk line with nothing before his eyes; then put in place over the other eye, or each in turn, a 10-degree prism, base down, and start him again along the chalk line. If he shows undue and sudden caution, the presumption is that he is

using both eyes and that the artificial diplopia is troubling him, but look out for his closing the poor eye.

A SPHERE BEFORE THE GOOD EYE.—First find the presbyopic correction for the sound eye, if necessary, and set it up in the frame, assuming that the two eyes are the same. Set the patient to reading the letters on the near test chart; now take a plano lens in one hand and a plus 6 say in the other, and while the reading is going on suddenly place the plus 6 before the sound eye, then substitute the plano, then the plus 6, etc. If a malingerer, he is very apt to be caught either by reading when the plus 6 is put over the sound eye which is manifestly impossible, or by pretending not to be able to do so when the plano is put in place.

DOUBLE PRISM TEST.—Adjust the double prism before the good eye as in the regular muscle test. The patient will see two lights, the supposed bad eye being covered. If he insists that he cannot see two of them then he is a malingerer, or if when the disc is turned he claims not to see the lights turn, then the decision will be the same. Supposing that he acknowledges the two lights; then hide the light for a moment by getting in the way; take the handle of the double prism in one hand and the opaque disc over the other eye in the other hand, and at the same time that you remove the opaque disc also lift slightly the double prism so that he only has one of the prisms in front of the eye; then step to one side; it is evident that if he now sees two lights, both eyes are being used.

THE MOVABLE LIGHT TEST.—Have the patient look with both eyes uncovered at a small light on the opposite side

of the room; at the same time have another light three or four feet to the side of it, which the examiner is to hide by getting in the way, it being necessary for this purpose that he be in front of the person under test. Take a card in one hand and pass it from eye to eye as in the ordinary objective cover test, but suddenly at the same time as he shifts his body so as to hide the first light and uncover the second, also cover the good eye. If the bad eye responds to light it will at once fix the new light, which will be in the nature of a surprise, followed perhaps by a turning away of the eyes, which will clearly show deceit.

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CHAPTER IX.

SPASM OF THE ACCOMMODATION.

The word spasm means the involuntary and unnatural contraction of a muscle, which may be of two kinds, tonic or clonic. In tonic spasm the contraction is steady; in the clonic form there is alternate contraction and relaxation. In either case we have a pathological condition, which, under proper treatment, may be expected, sooner or later, to disappear.

Let us imagine a patient whose crystalline lens is hung slightly out of true, but which comes into alignment with the exercise of the function of accommodation; or let us suppose that the suspensory ligament contains a slight fold which straightens out as the accommodation comes into play. The owner of such an eye will see better with the accommodation in force than without, because in his case it is only when the ciliary muscle is moderately exerted that the clearest and best image on the retina is formed. Under a subjective test, not properly checked up, the patient will show an ocular refractive condition quite different from that obtained under atropine, but where the finding is checked, by the addition of a plus 1 lens for instance, to see whether the blurring caused by this lens is of normal amount, the error will be seen at once and can readily be avoided. This case might readily be pronounced one of spasm of accommodation, and yet there would be no spasm present. We must be sure, in making our tests, that there is no accommodation in play. To this end it is always

necessary that the patient should be fogged at least sufficiently so that with all the relaxation of the ciliary muscle possible, the eye will still be slightly artificially myopic. Furthermore, we should always be sure to check up our own work, for we are just as apt to make mistakes as are our patients to give misleading answers to our questions. I will give here two methods of check testing, either one of which, or both, should be employed in every case. The first one, already referred to is to add a plus 1. diopter lens to the distance finding and see if the blurring of the letters on the chart is as great as should be the case; if not, then there has been a mistake. The second method is to place a plus 3 lens over the distance correction, and then see if the far point has been brought to 13 inches from the eye; if not, an error has probably been made.

Let us now take another possible case, that of a woman with whom the subjective test moves smoothly at first, but whose vision suddenly changes. After we have brought, by the usual manipulations with lenses, the patient's vision to 20/20, her eye seems suddenly to give out, and vision drops to 20/30, or worse. This leads us naturally to repeat our test from the very beginning, but perhaps this time we get 20/15 with findings quite different from the first, only to have it fall off in the same way as before. Such cases are in the experience of all optometrists; they take up a great deal of time, for we try and try again, each time feeling sure that we will get the correction, only in each case to fail once more. Now it is very easy to say that this is a case of spasm of accommodation, but careful and special tests, including the retinoscope and the ophthalmoscope, will show that the trouble is strictly a retinal one. The retina usually is exasperatingly healthy looking, but the fact that the visual acuity varies while the retinoscope test made at the same time shows no change in

refraction, proves that the trouble is not due to the ciliary muscle. What must be done in a case of this kind is to bring the ciliary muscle to a condition of relaxation and keep it there; then at the beginning of the test cut down the illumination of your test letters to one half or less of the usual intensity; work fast, resting the patient's eyes during the changing of the lenses by cutting off or screening the test letters; and at the last moment check up the findings with the illumination of the usual brightness.

There is a second form of these cases which is apt to be peculiarly exasperating. The patient has astigmatism, the principal axis being found in the usual way by slight fogging. As we apply minus cylinders all goes well until we get close to full cylinder correction, where the patient will see the wrong lines best; for instance, she may have been seeing the 120th meridian the clearest, but changes suddenly to the 150th or the 90th, or possibly to all three in turn. When we reduce the cylinder the 120th comes out all right again, but as we come once more to the critical point the phenomenon is repeated. We try shifting of the cylinders a trifle; sometimes this plan works, but usually it does not. There is no doubt that this is a variety of spasm of accommodation of low degree; the symptoms show clearly that accommodation of variable amount is being used. It is assumed to be true that some of those who have astigmatism focus ordinarily for a point between the two meridians of their astigmatism, and it is quite possible that this habit becomes so fixed that the eyes never fully relax, but when fogged are short of relaxation by one half of the amount of the astigmatism present. Under these circumstances, as we come close to the point in the test where the astigmatism is fully corrected, the physiological desire for clear vision, as the patient looks at the various lines of the astigmatic chart, becomes so strong that the slight spasm is released

and the eye becomes focused for a set of lines not coincident with the principal meridians of the eye.

A method which will be found most excellent in these cases is that of the use of the astigmatic cross. This consists of two sets of lines of the same size as those of the clock dial chart, and similarly spaced, crossing each other at right angles. After the directions of the two principal meridians of the eye under test have been found, the clock dial chart is removed, and the cross having been set to agree with these principal meridians, is used in its stead. There is no tendency of the eye, now, to accommodate for lines to one side, for these lines have been removed. What remains to do is to apply the minus cylinders until the two arms of the cross are exactly alike. This method is rapid and satisfactory in the class of cases under consideration, and, in fact, after the test with the cross has been completed the patient will then see all the lines on the dial alike. After the astigmatism has been corrected the examination for the finding of the spherical ametropia can then be continued.

A fourth class of case is the hypermetropic child whose accommodation is active and who really sees a little better with the accommodation in force because he is accustomed to see in that way. To prescribe a minus glass in these cases is inexcusable, for the ordinary check test of a plus one added to the distance correction at the end of the examination will show clearly if an error has been made. Suppose we make some experiments; let us take the distance correction of various patients or friends, who will act as our subjects; over their distance correction we will place a plus one lens; then we will carefully test them all and see to what extent the letter chart is blurred; and we might try the same experiment with a plus two. Now suppose, in the case of a given patient whom we think we have exactly corrected,

we apply an extra plus one or plus two, and the blurring produced is much less than it should be; then the case is clear; we have made a mistake in our fitting, one which we would pronounce later as due to spasm of the accommodation.

As to cases of typical spasm, which in some cases will not unlock at all. while in others the spasm is clonic, first on and then off, it is quite within the bounds of reason that there should be such cases, though they are extremely rare, so rare that we must look upon them as diseased ocular states. On the other hand, the so-called tonic variety; these are moderately common. In these cases we usually find a condition of hypermetropia, which, as the result of wearing correcting glasses and the consequent rest of the ciliary muscle, is found to be increased at examinations subsequent to the first. We might call these spasm of the accommodation, but hypertrophy or over-growth of the ciliary muscle would be a better term. Like the muscles of a heavy athlete the ciliary muscle in these cases, because of its continual exercise, grows in size; the various minute particles of which it is composed are overgrown and block each other's way so that relaxation is limited, but as the result of the decrease of the abnormal amount of exercise to a normal amount; this brought about by the wearing of correcting plus lenses; the muscle particles, or cells, decrease in size and thus permit a greater lengthening, thereby causing in turn a further development of the latent hypermetropia, until at last the process comes to an end, when all that hypermetropia which was latent becomes manifest. There exists no spasmodic condition here, for by the definition of the word spasm we must have an involuntary and unnatural contraction of the muscle which is not permanent. Now hypertrophy of the ciliary muscle is approximately a permanent condition, only decreased gradually as the result of the advance of presbyopia

and wearing of plus lenses, and in none of its symptoms complying with the requirements of a spasmodic condition.

Let us take up still another form of "spasm," a typical case of pseudo myopia: A child of 12; vision, 20/80; with a minus 1.50 sphere, vision 20/20. This prescription, however, does not relieve the headaches. Examination after atropine: vision 20/200, when a plus 1.50 sphere combined with a .62 cylinder axis oblique gives 20/15; and in a few weeks the little patient is cured of all headaches and nervous reflexes. The case is reported by a beginner. On the other hand, we have the brief statement of Tscherning that all cases of spasm of accommodation are relaxed after a few moments in the dark room; also the statement of Bull that after a thorough test of the fogging method he has ceased the use of atropine in refractive work as entirely unnecessary. How are we going to reconcile these conflicting statements? The truth probably is that the examination was carelessly made in the first place, or the patient in question may be a malingerer. A little girl may have a chum who wears gold glasses, and she may have such a strong desire for a pair, too, that her vision very accommodately fails accordingly. In a certain case of this kind the little girl stated that when her eyes were being tested that she could scarcely read the letters on the chart with the naked eye, but that with each change of lens she saw better until the fourth lens, which she claimed was the best. As a matter of truth she was a hyperope of 1.50 diopter only and could read the whole chart without glasses and with ease, the same also being true of the fourth lens tried. Later, when taken to the oculist because of headaches, the supposed error on the part of the optician was made clear.

I believe in the possibility of ciliary spasm. If we severely overwork one of our muscles we will often get a cramp in it.

In certain diseases the muscles will be cramped without over-exercise; why should this not be just as true of the ciliary muscle? I believe it is. What are usually known as spasms of the accommodation, however, are those cases which have been incorrectly fitted with weaker plus or stronger minus lenses than the ocular refractive condition demands.

In spite of the fact that spasm of the accommodation is rare, we must nevertheless be constantly on the lookout for it, so that should a case pass through our hands we may not be held up to ridicule later as incompetent by those who, perhaps, are less skilled than we. To avoid such a result we should always test the amplitude of accommodation and the near point. The tables for these, first given by Donders, are, with rare exceptions, correct, and when we find one of these exceptions we must at once assume an abnormal condition, though later we may have to give up our provisional hypothesis, for among human beings there are always physiological exceptions to be expected.

The whole solution of the difficulty lies really in the use of the fogging method. By this term is not meant the method which is generally used; the placing of a strong plus lens in front of the eye followed by minus lenses placed in front of it, commencing at a minus .25 diopter and gradually working up by steps of minus quarter diopters, thereby gradually reducing the combined value of the two lenses used until we reach the Mecca of all eye testing, the strongest plus or the weakest minus. Such a method is good in theory, but there is always danger that we will go too far in our reductions by minus lenses and after all make errors in spite of all our care. A better and a quicker way, one to employ as a matter of routine, is to place a plus 4. diopter lens before the eye under the test; allow it to remain in place a minute or so; then, taking a chart in the hand on which there

is a small astigmatic dial or fan, hold it about a meter from the patient and proceed to find his artificial far point. If he is an emmetrope this point must be at 10 inches. Should the test, however, show it to be further away than this distance, then we know that he is hyperopic, and by measuring the distance can readily calculate the approximate amount. Should some one line on the chart come out clear before the others, then we know that astigmatism is present and can estimate the dioptric power of the corresponding meridian of the eye. Then to find the power of the other meridian leave the plus 4 lens in place, but put in front of it a strong plus cylinder, axis to agree with line first seen clearly. This will usually reverse the astigmatism lines as the chart is brought near, and on repeating the test the line at 90 degrees from the first one will come out clear first. By noting and measuring the point where this occurs we can estimate the refraction of its corresponding meridian. From the two findings, by the rules of transposition, we can write our first or temporary prescription for distance.

The next point is to find the artificial near point for both meridians, from which may be figured the amplitude of accommodation. In view of the fact that up to the point of finding the near point the eye has been fogged, we can safely assume that any spasm present capable of relaxation without atropine, will be thoroughly relaxed, and hence if the amplitude of accommodation is too deficient in amount, that we have a case beyond our province, to be recommended without delay to the specialist, because it is a safe assumption that such a lack in the power of accommodation is a diseased ocular condition. However, if we do not find this lack of accommodation, we will proceed at once to examination at 20 feet to check up and modify our visual finding.

Looking at the matter from another point of view, we can divide spasms of accommodation into two forms, the true and the false. In the true spasms there must be pain and undue loss of power of accommodation, cut off at both ends. Such a case will be made clear from the history of the trouble, but principally from the patient's statement that at times vision blurs for both far and near, the distance correction being worn; all which can be verified in the examination room by the tests for far and near points. It is true that the supposed spasm may really be paresis of the accommodation, but here we should not expect ocular pain, simply the near point would be unduly distant after correction of the ametropia, and the amplitude of accommodation would be deficient, while the blurring, provided glasses for distance were worn at the time, would be for near work only. The false form of spasm of accommodation is really hypertrophy or overgrowth of the ciliary muscle. In this case the near point will be normal, the amplitude of accommodation will be lowered, there will be no eye pain, though there may be headache, and the finding under the fogging method will always be hypermetropic.

UNCOVERING LATENT HYPEROPIA.—After the supposed correction has been found, add an extra plus 1. D. to the combination already set up which will blur, and let the patient look at the distant chart to see if at the end of a few minutes certain lines will not come out clear which were not clear at the time of inserting it in the frame. A second method is to add a plus 4 to the correction for distance; leave in place for a few moments, then hold a minus 3. in front of the plus 4. and see if the vision for a moment is not very clear followed by a blurring which would be the coming on of the spasm.

APPENDIX.

CORNEAL AND OTHER TESTS.

These are tests of diagnosis. They are not strictly trial case tests, but they are included here because they should never be omitted. They seek to make clear corneal conditions of surface which are probably interfering with good vision; for instance, one of the results of trachoma in some cases is the roughening of the surface of the cornea, which, of course, will, to a certain extent, make the image of objects more or less diffuse, with no possibility of correction; or there may be corneal scars present due to various causes, all of which, so far as vision is concerned, are insuperable difficulties. There are but two corneal tests in general use, excepting direct inspection by means of a magnifying lens, with or without the use of the mirror of the ophthalmoscope or retinoscope, and these are Placido's disc and the ophthalmometer.

PLACIDO'S DISC.—This is a black disc on which are drawn a series of concentric white circles. A bright light is placed behind the patient which is made to shine on the disc, this latter being held in such a position that its reflection is seen on the surface of the cornea. By the image thus formed, whether smooth and clear, or distorted and dulled, we can form a good idea of the corneal surface.

THE OPHTHALMOMETER.—When this instrument was first devised it was hailed as a complete solution for the diagnosis of the character of astigmatism and the amount of cylindrical correction needed to make any given eye of an exact spherical correction. This has proved to be not always true, though there are still a certain number of people who rely upon its findings implicitly. The trouble is that corneal astigmatism is not the only kind in the eye, and no matter what the amount due to the toric curvature of the cornea itself may be, this is no certain guide

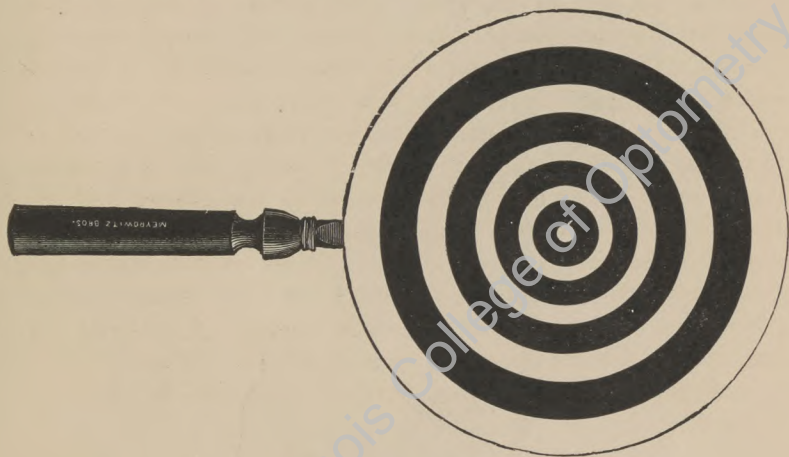


Fig. 28.—Placido's disc.

to the total amount of the eye. However, as an instrument of diagnosis the ophthalmometer is very sure. It will show us the nature of the corneal surface, and by the result of this knowledge we may sometimes more intelligently know our limitations in fitting the eye for glasses in a given case.

The surface of the cornea is a very fine convex mirror, and

the ophthalmometer utilizes this fact. The instrument consists of a special sort of telescope, through which we look on the patient's cornea at two mires or targets which are reflected on the surface. These reflections we examine through the tele-

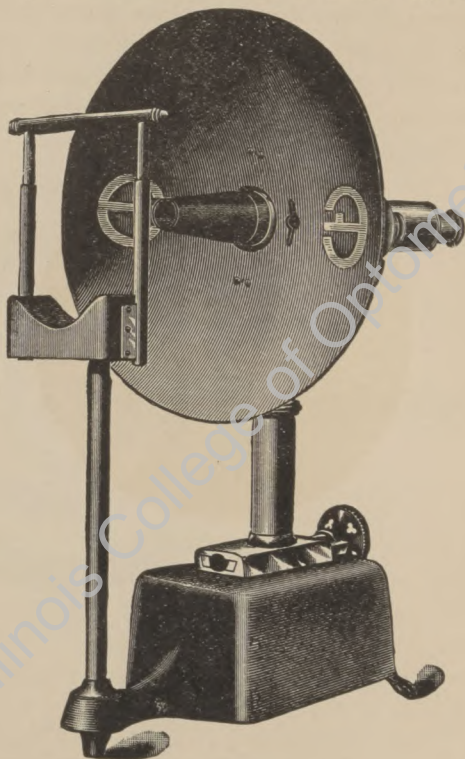


Fig. 29.—Ophthalmometer.

scope. The illumination for the mires may be lights shining directly upon them, or it may come through translucent porce-

lain from behind. The patient rests his chin upon a convenient, adjustable chin rest, and looks steadily with one eye into the barrel of the telescope. The examiner from behind adjusts the telescope so that he gets a clear image of the two mires on the reflecting surface of the cornea. These mires are so arranged that they can be swung to any meridian of the apparatus, and they also have two guide marks, one corresponding to the line that joins them and the other shorter and at right angles to this

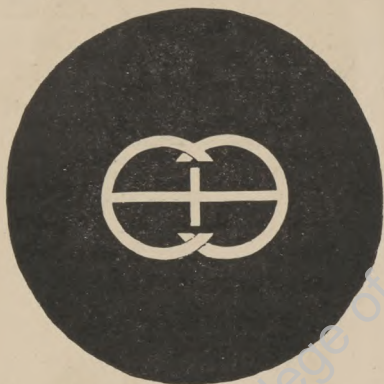


Fig. 30.—Mire of ophthalmometer as seen reflected by cornea.

direction. The instrument is turned on its horizontal axis until the two longer guide marks as shown in the images are in a line; then the lights are brought nearer together or farther apart; or in some instruments the same final result is reached by a pair of prisms in the body of the telescope; until the two cross guide lines correspond. The instrument is now rotated to see if there is corneal astigmatism present, which will become known by the relative position of the mires. If there is astigmatism present, the two longer guide lines will separate on the rotation of the instrument only to coincide again when the other principal merid-

ian of corneal curvature is reached. The cross guide lines will now be found not to match, and their difference in position is the measure of the amount of corneal astigmatism present. To find just what this amount is in diopters a suitable calibrated scale is attached to the ophthalmometer.

FIELD OF VISION.—This is usually found with the perimenter, but can be taken roughly in the following manner: Optometrist and patient should sit facing each other squarely, and should look fixedly at each other's noses. The optometrist should now take a small ball, or cube, and hold it far to one side and exactly midway between himself and his patient. Now draw the object nearer and nearer to the center line until the patient can see its color. Repeat in various directions. Compare the points at which the patient can begin to see the objects and their colors, with the optometrist's power to do the same, whence the condition and limits of the visual field can be roughly estimated, those of the observer being previously known.

THE RYER TEST.—In this test a special, revolving astigmatic chart is used. It is laid off in white and black squares, very similar to a checker board. Supposing the patient is astigmatic, even to a very small degree, he will see these squares distorted, except when the lines forming them correspond exactly in direction with the meridians of greatest and least dioptric power of his eye. This peculiar distorted appearance is very marked. To use this method place the chart 20 feet away from the patient and then cause it to revolve, meantime having the patient watch it closely. If the eye is astigmatic and can focus the chart clearly, the axis can be very closely determined. The chart should then be set so the lines forming it agree with the

two principal meridians of the eye, and, cylinders be applied, axes to agree with the directions of the lines, until the whole chart stands out clear, the lines in both direction equally black and the white squares of the chart with sharp edges; no blurring.

Both plus and minus cylinders should be tried, as where the

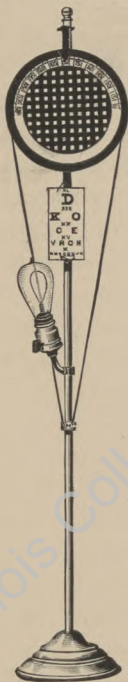


Fig. 31.—The Ryer Astigmometer.

astigmatism is marked sometimes the plus will give the closest results, at other times the minus. It will be noted that if both are used in the test they will have to be applied at opposite

meridians; for instance, if a plus 1. D. cylinder axis 90° will make the chart clear, it will require the minus 1. D. cylinder which produces the same effect, to be at axis 180 degrees. After the astigmatism has been corrected, spheres should be applied in the usual way, the strongest plus or the weakest minus. The Snellen's letter chart attached to the instrument may be used for this part of the test.

If the eye under test, because of high ametropia, cannot focus the chart at 20 feet, or if the eyes are amblyopic it should be brought nearer, or plus lenses may sometimes be necessary. To clear up this point the letter chart can first be used at varying distances and an idea formed of the focusing power of the eyes, when lenses may be used, if necessary.

Some Criticisms on the Lockwood Series

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This work meets the conditions of a fine work of instruction.—Medical Brief.

This little book is likely to prove of very great use to elementary optical students, as it treats of optical questions without unduly dipping into mathematics. The chapters are on lenses in general—convex lenses, the wave theory, concave lenses, compound lenses, lens measurements, cylinders, spherocylinders and prisms.—*Dioptric Review.*

A simple, but well-arranged little illustrated text book, especially designed to ground students in optometry and to assist in preparing them for examinations. It is, in these days of education and examinations, essential that there should be some simply written work which can be of service alike to the student and examiners. This little book fills a gap, and will be appreciated by those who are interested in the examination and certification of opticians.—*The Watchmaker, Jeweler, Silversmith and Optician.*

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This is the second of a series of practical handbooks the author intends to present. The predominant feature of the book is its practicability. The author's style is clear, the arrangement of the book well-ordered, and the result, a simple, handy reference book on this particular subject.

Next to its practicability, which, however, is the chief aim of its author, stands its brevity, not that it is incomplete, but concise. Though the subject may be classified with those most extensively treated, it seems, herein entirely new—a sense of freshness prevailing, with a lack of time-worn, hackneyed phrases. Some of the methods now employed are questioned, and improvements are suggested. The illustrations are profuse, adding considerably to the text.

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Mr. Lockwood has succeeded in producing a very clever little book which should act as a preliminary elementary study of the trial case. But it is put in popular English and is understandable. It deals very cursorily and rapidly with the anatomy of the eye, the instruments used in the test case, and a few directions for removing cinders, etc., from the eyes. The book is certainly well worth the purchase.—*Dioptric Review.*

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